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STUDIES IN NICOTIANA, I

BY
WILLIAM ALBERT SETCHELL

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STUDIES IN NICOTIANA. I.

BY

WILLIAM ALBERT SETCHELL

In 1906, as a consequence of a certain interest in the history of the origin and spread of the use of tobacco, I began to cultivate such species of *Nicotiana,* both native and horticultural, as I could obtain seed of, in the Botanical Garden of the University of California. In all a total of 103 packets were sown that year, and from 75 packets good plants were obtained. Of many of these, seed was produced under bag and for the most part this "pure seed" was from a single plant. Since 1906 the sowings have been continued each year, from seed of the previous year, as well as from seed from new sources, until finally a very considerable assortment of species and varieties have been grown. Gradually the number of plants have been reduced and selected to a certain number to serve as a stock for breeding. It is my intention in the present volume to publish the results of the experience of myself and others, in connection with the cultivation and experimentation with this stock of *Nicotiana* in the Botanical Garden of the University of California.

The expenses of these investigations have been borne partly by the funds granted by the President and Regents of the University of California for the up-keep of the Botanical Garden and partially by certain allotments from that portion of the Adams Fund of the United States Department of Agriculture granted to the Agricultural Experiment Station of the University of California. Through these means the work on the *Nicotiana* species, detailed in this volume, has been carried on.

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The sources of supply for seeds have been collectors and botanical gardens. From various collectors, seeds of wild species have been obtained, particularly of the Pacific Coast and of Texas. From the botanical gardens of Europe and America I have been able to obtain seeds of most of the cultivated species, and from the various divisions of the Bureau of Plant Industry I have been able to obtain seeds of many of the cultivated varieties and forms of *Nicotiana Tabacum.*

At first the study was largely systematic and morphological, with the entirely and naturally to be expected result that it was found that very considerable confusion existed in the naming of the different plants. Some two or three years were devoted to growing almost everything that could be obtained and attempting to straighten out the nomenclature, which has been a matter of no little difficulty. The only recent revision is that of Comes (1899) and this has been used, so far as it clearly applies, in unravelling the tangle of names current in trade and in the botanical gardens.

After careful growing and selecting, about seventeen species as generally recognized, remain, together with some well-marked varieties. It seems best to enumerate and discuss these to some extent, in order that a basis may exist for more exact knowledge of the work in the following pages. I hope, also, to be able to return to these later and publish a critical discussion of them.

Comes in his "Monographie du genre Nicotiana" (1899), divides the genus into four sections, viz., I, *Tabacum*; II, *Rustica;* III, *Petunioides,* and IV, *Polidiclia.* This classification is that of G. Don (1838) as well as of Dunal (1852). For reasons which will be discussed in a later paper, it seems that IV, viz., *Polidiclia,* cannot be separated from III, viz., *Petunioides.* Consequently I have retained I, II, and III, and will discuss the stock of species and varieties collected in the Botanical Garden of the University of California under these three sections. (At the very time of writing this, I receive East's paper (1912) entitled "A Study of Hybrids between *Nicotiana Bigelovii* and N. *quadrivalvis.*" He also gives very convincing reasons for combining the sections *Petunioides* and *Polidiclia*).

Section I. Tabacum G. Don

Nicotiana Tabacum L.

Under this section there is usually included only one species, viz., *Nicotiana Tabacum* L. It seems to include all those species of *Nicotiana* in which the corolla is of various shades of red or occasionally white (albino?), infundibuliform, with the throat somewhat to much inflated, and with the limb patent. The flowers are in panicled corymbs. Under the single species *N. Tabacum* is grouped a most varied assemblage of varieties, forms, and suspected hybrids as ever were brought together under one specific name. Comes (1895, 1899, and 1905) has attempted to arrange the various forms under some six varieties and also under various supposed combinations of hybrid origin. The result has been to bring some order out of chaos and to point out certain experimental possibilities. Anastasia (1906) has also concerned himself with an inquiry into the typical varieties of *Nicotiana Tabacum*. He differs somewhat in his ideas from Comes. Howard and Howard (1910) have attempted to arrange and illustrate the types of Indian tobaccos constant in their characters, and Hasselbring (1912) has just discussed the types of *N. Tabacum* grown in Cuba, showing that they remain true to type when grown also in Michigan.

In these various papers it is evident that all the variety of plants to be referred under *N. Tabacum* in its broad and comprehensive use fall under seeming combinations of a few types. The further question as to the origin of these combinations has, as yet, been merely suggested but not proven. Probably there will be no exact agreement, for a while, as to just what the simplest expressions of the fundamental types are, nor can it be settled except by continued and extended experimentation, if it can ever be settled at all. Comes has selected and described six typical varieties and referred all others as combinations of two or more of these. Anastasia thinks that there are only four. I have tentatively selected five as seemingly fundamental. These three sets thus selected are not coincident for the greater part.

Since it is my intention to discuss this matter later and since, at present, it is desirable only to enumerate and make reasonably plain what plants have been used in the work carried on in the Botanical Garden of the University of California (U. C. B. G.), I shall content myself with giving a list with descriptive remarks of the types which have appealed to me as being possibly fundamental or of other interest in experimentation. In connection with each I shall use the number by which it has been designated in the U. C. B. G.

"Brazilian"

U. C. B. G. $\frac{71}{05}$.—The seed of this number was received under the name of "Choice Brazilian American" from the United States Department of Agriculture in 1905. Its habit and general characters are well shown in the photograph reproduced in plate 1. It is a tall plant, averaging about six feet in height, producing laterals in succession above, but barely being overtopped by them. The leaves are long, broad, and decidedly cucullate at the tip. They are thin and silky in texture, being minutely glandular-pubescent. The corolla is pink, tubular below gradually and moderately infundibuliform above, being more swollen than $\frac{68}{07}$, but less so than $\frac{72}{05}$, about equally so with those of $\frac{78}{05}$. Altogether the plant is very near to a plant grown in the U. C. B. G. from seed sent by Professor Dr. O. Comes, labelled as being of his *Nicotiana Tabacum* var. *brasiliensis*. It does not seem to answer exactly to his figure of that variety (1899, VI) nor exactly to that of *N. Tabacum* var. *havanensis* (*loc. cit.* VII). In his later work (1905, p. 81, fig. 27) Comes figures a plant which he designates as "Bahia" and which he considers as a combination of his varieties *brasiliensis* and *havanensis* which is close to our plant, but not exactly of the same inflorescence at least. The plant designated by Anastasia (1906, opp. p. 102) as *N. Tabacum* var. *brasiliensis* is very nearly the same as ours. It seems therefore, that we may designate the plants bred from $\frac{71}{05}$ U. C. B. G. seed as "Brazilian." Its exact characters and relation to other "Brazilian" combinations as well as "Havana" combinations will be considered when certain experiments involv-

ing it as one of the factors are discussed in a paper which it is hoped may be published later.

"Cavala"

U. C. B. G. $\frac{72}{05}$.—The seed from which the plants were raised and continued under this number in our botanical garden was obtained from the United States Department of Agriculture. They were labelled "Cavala Tobacco" and were No. 11497 of the U. S. D. A., obtained from Turkey. The habit and general characters of the plant are well represented in the photograph reproduced on plate 2. It is a tall plant with upper and middle laterals which more or less overtop the original panicle. The leaves are short, compared with those of nearly all the other members of the *N. Tabacum*-group, peculiarly and more decidedly rugose on the upper surface as well as velvety, shaped more like those of $\frac{22}{07}$ (*Nicotiana Tabacum* var. *macrophylla* Comes) but more tapering towards the base and long and narrowly decurrent. The flowers are also nearer to those of $\frac{22}{07}$ than to the others. In color, however, they are pink. The lobes are broad and rather shallow, but they are tipped with a short recurved point. The tube is slender below but is stout and broadly infundibuliform above.

This plant is not to be identified with any of the typical varieties of either Comes or Anastasia. Nor do I identify it with any of the cultivated varieties figured by them. I shall simply call it *Cavala* and discuss its position and influence in breeding, later. The texture of the surfaces of the leaf and the shape and decurrence of the leaf make it a desirable plant in crossing.

"Maryland"

U. C. B. G. $\frac{78}{05}$.—The seed from which the stock of plants designated by this number has been obtained was distributed by the United States Department of Agriculture in 1905, and designated as "Maryland," with the identifying number "205–20–7." In habit, as well as other characters, it is decidedly different from the two varieties just described. It is of some-

what lower stature and the spreading leaves at the base give it a sort of pyramidal (or conical) shape (cf. plate 3). The leaves are long, broad in the middle and tapering very rapidly to each end. At the apex is a fairly long point curved to one side, while the base is narrow, to expand at the junction of the stem into two broad clasping auricles. The panicle is ample as compared with that of other members of this section. The flowers are very light pink, with slender tube and infundibulum and with the limb broadly but deeply lobed. The lobes have slender incurved points. It would be classed by both Comes and Anastasia as a combination form under *Nicotiana Tabacum* var. *virginica*. It comes near to the plant figured by Anastasia (1906, opp. p. 30) and by Comes (1899, pl. V) but is not identical with either. It seems best to call it "Maryland." The original *Nicotiana virginica* Ag. (1819, p. 18), as represented by the type-specimen in the Herbarium of the University of Lund, is of the same general type, as is also the type of *Nicotiana Tabacum* L. of Linnaeus's herbarium in London. The type-specimen of *N. fruticosa* in the Linnaean Herbarium seems also to belong here but may possibly, however, represent the plant referred by Anastasia (cf. above under U. C. B. G. $\frac{71}{05}$) to var. *brasiliensis*. The plant in Hb. Agardh is decidedly narrow-leaved and may be near to what Comes (1899, p. 10, pl. IV) has called var. *lancifolia*. From what could be seen of the flower, it seemed to be broader-lobed than that represented by Comes for this latter variety.

Nicotiana Tabacum var. **calycina**

U. C. B. G. $\frac{110}{05}$.—This is the plant known in botanical gardens as *Nicotiana Tabacum* var. *calycina*. The seed was received from the Botanic Garden of the University of Cambridge in 1905. It has remained constant in its peculiarities, ever since, under conditions of pure-line breeding. In habit, it is peculiar, as shown in the photograph reproduced in plate 4. The lower laterals soon come to equal the main axis or even slightly to overtop it, so as to obscure it as a main axis. The leaves are large, approaching in shape the members of the *virginica*-group

(such as U. C. B. G. $\frac{78}{05}$). The lower leaves are broader (proportionally) in the middle and taper more abruptly to each end than do those of the *Maryland* (U. C. B. G. $\frac{78}{05}$). The auricles at the base are hardly discernible in the *calycina,* while they are decidedly pronounced in the *Maryland.* While this plant is distinct in habit and leaf, it is still more characteristic in its flower. The flower is double of the "hose-in-hose" pattern. The calyx is more or less petaloid and colored bright pink or light red, as is also the corolla. Sometimes the whole calyx is petaloid in color (whitish tube, pink above and deep pink limb) or it may have some green in it, usually irregularly distributed. Both calyx and corolla are split on one side, in most cases, and even to the very base. Both are deciduous, leaving the capsule naked. The lobes of the limb of both calyx and corolla are broadly but deeply lobed and the lobes have long laterally curved points. The capsule is more oblong than that of other members of the *Tabacum*-group. The inflorescence is more compact than that of other members of the *Tabacum*-group with the exception of the members of the group surrounding *N. angustifolia* (*N. Tabacum* var. *fruticosa* Comes, not Hook., U. C. B. G. $\frac{68}{07}$). In fact, this plant (U. C. B. G. $\frac{110}{05}$) combines characters of the *angustifolia*- and of the *virginica*-sections with its own peculiar teratological features. This plant will be referred to as *Nicotiana Tabacum* var. *calycina,* or simply as *calycina.*

"White Tobacco"

U. C. B. G. $\frac{30}{06}$.—A plant of the *Tabacum*-group with cream-white flowers has been bred in our botanical garden for several years, and in the pure-line cultures has retained its color and other characters perfectly. It came from seed distributed from the Missouri Botanical Gardens in 1905. An inquiry directed to Director William Trelease in 1910 as to its source, brought out the information that the original plants were found by him in Mexico, growing "in that interesting little village, Maltrata, at the foot of the first descent from the table-land down toward Vera Cruz on the Orizaba side." He

says further: "I found the ordinary pink-flowered form and the white one growing as wayside weeds and gathered a considerable quantity of the white form because of its striking appearance. From the occurrence of the plants I should suppose that there was every reason to anticipate crossing of the two forms but, so far as I knew of it, all of the seedlings that we raised from the white seed bred true." Our experience has been that it breeds true when protected by bag, but one year, seed which had been taken from an unprotected plant gave a pink-flowered form whose bagged seed, in turn, gave a considerable variety of colors, stature, etc., in the plants raised from them.

The *White Tobacco* as we have called it, is a tall plant, up to six feet high and over, of simple habit, only the upper flowering laterals developing. It is well shown in the photograph reproduced in plate 5. The leaves are much like those of *N. Tabacum* var. *macrophylla* Comes (U. C. B. G. $\frac{22}{07}$) except that they are more rounded at the middle, have a decidedly prolonged point, and are rugose and downy above. The flowers are like those of U. C. B. G. $\frac{22}{07}$ except in color.

This is a most interesting plant. It has the habit more of the *Cavala* (U. C. B. G. $\frac{72}{05}$) of which it has also the peculiarities of the surface of the leaf (both rugosity and downiness). It has, however, the general leaf-shape and flower-shape of U. C. B. G. $\frac{22}{07}$ (*N. Tabacum* var. *macrophylla* Comes), and these are combined with an apparently albino character in the flower. It is a poor seeder, a characteristic pointing toward a possible hybrid origin. The seed is apt to be both comparatively scanty and of poor germinating power.

Nicotiana Tabacum var. **macrophylla**

U. C. B. G. $\frac{22}{07}$.—This is the *Nicotiana Tabacum* var. *macrophylla* of Comes and was grown from seed kindly supplied by Professor Comes from his plants at Portici near Naples. It has the essential characteristics described and figured by him for this variety (cf. Comes, 1899, p. 18, pl. VIII), but does not

correspond perfectly to his figure. It is a low plant with ascending laterals and broad leaves. The habit is well represented in the photograph reproduced in plate 6. The leaves are broad proportional to their length, rounded and abruptly narrowed into a very short point above, but gradually tapering to a broad clasping base below with rounded but not prominent basal lobes (hardly to be termed auricles). A comparison of the habit-photograph mentioned above with the plate of Comes will show how U. C. B. G. $\frac{22}{07}$ differs from his var. *macrophylla*. The flowers are deep rose color to red with stout tube and abruptly swollen, broad infundibulum, and with the limb almost pentagonal. It is marked at the very shallow sinuses with triangular depressed whitish areas as represented in the figure of Comes (1899, pl. I and pl. VIII). The capsule is broad, short, rounded and nearly enclosed in the calyx (cf. Comes, 1899, pl. I). This will be referred to as *Nicotiana Tabacum* var. *macrophylla*.

Nicotiana angustifolia

U. C. B. G. $\frac{68}{07}$.—The seed whence the plants designated by this number have sprung was obtained in 1907 from the authorities of the Jardin Botanique de la Faculté de Medecine du Lyon, under the name of *Nicotiana angustifolia*. It is the plant known early under the name of *Petum angustifolium* (cf. Clusius, 1605, p. 310) and has passed by the name under which we we received it since 1768 (cf. Miller Dict. ed. viii). It belongs to the group of *Tabacum* varieties placed under *N. fruticosa* or those with distinct and non- or only slightly alate petioles. It is very near the *N. Tabacum* var. *fruticosa* of Comes (1899, p. 8, pl. I, III), but that is evidently not the *Nicotiana Tabacum* var. *fruticosa* of Hooker (1876, pl. 6207) which is a plant with a sessile clasping leaf and much nearer to U. C. B. G. $\frac{71}{05}$. It is not the same plant as the one in the Linnaean Herbarium preserved as the type-specimen of *N. fruticosa* L. It is impossible for me, at present, to attempt to unravel the synonymy of this plant further, but it will be quoted in the following pages as *N. angustifolia,* using this binomial simply as a convenient

designation for the present. It is not *N. angustifolia* Ruiz & Pavon, however.

N. angustifolia, or U. C. B. G. $\frac{68}{07}$, is a comparatively low plant, about three feet in height as a rule, of decidedly corymbose habit, i.e., the main axis is of limited growth in height and is soon equalled or even overtopped by several (or all) of the laterals. A young plant is represented in the photograph reproduced in plate 7. The leaves are distinctly petioled and the petiole is naked, at least in the lower half or third. The blade of the leaf is obliquely ovate-lanceolate, tapering gradually into a long, laterally curved point. The base of the blade is broadly rounded and is decurrent along the upper half (or even two-thirds) of the petiole as a narrow wing. The blade is more or less conduplicate. The upper leaves are shorter-petioled, narrower, and shorter-pointed than the lower, while the uppermost are often reduced to very narrow linear shapes. The petiole is provided with two sharp angles at the junction of the upper (almost flat) and the lower (very convex) surfaces. There are no auricles at the base of the petiole. The panicle is crowded with slender flowers. The calyx is narrow and with long slender lobes. The tube of the corolla is slender below, expanding gradually and not considerably, into a narrow infundibulum. The tube of the corolla in *N. angustifolia* is the most slender, especially as to the *infundibulum,* of any of the *N. Tabacum* group. The limb is very light pink and deeply divided into narrow lobes which are broader below but above are abruptly narrowed into long, slender lanceolate tips.

In habit U. C. B. G. $\frac{68}{07}$, or *N. angustifolia* as we may call it, is near to U. C. B. G. $\frac{22}{07}$, being more slender, but in its petioled leaves, its crowded panicle, its slender flowers with narrowly and deeply lobed limb, it is most distinct from all others of the *Tabacum*-group under cultivation at present in the U. C. B. G.

Nicotiana Tabacum var. **macrophylla purpurea**

U. C. B. G. $\frac{25}{06}$ was received from the Missouri Botanical Garden in 1906 under the name of *Nicotiana sanguinea.* It is

one of the plants usually known in gardens under that name. It is tall, six feet high or over, with large deep-red flowers, of the same shape as, though with rather deeper color than, those of *N. Tabacum* var. *macrophylla* (cf. U. C. B. G. $\frac{22}{07}$). *N. sanguinea* is designated by Comes (1899, p. 20) as "*N. Tabacum* var. *macrophylla purpurea,*" but it is to be noted that he expressly states that his *N. Tabacum* var. *macrophylla purpurea* includes both *N. sanguinea* and *N. purpurea* of the gardens, but only partially as to each. These two garden tobaccos vary in height, robustness, and color of flower. Even the shape of the flower varies among the different plants referred here. The leaves are ample, with fairly long, broad-winged petiole, broadly ovate blade, which is more or less cucullate at the tip. There are combined in this plant characters of our *N. angustifolia* (U. C. B. G. $\frac{68}{07}$) as to petiole, *N. Tabacum* var. *brasiliensis* (our *Brazilian,* U. C. B. G. $\frac{71}{05}$) as to cucullate tip, tallness, and perhaps also the wing on the petiole, and *N. Tabacum* var. *macrophylla* (cf. U. C. B. G. $\frac{22}{07}$) as to flowers. I have produced plants similar to this, but lacking tallness and the cucullate tip to the blade of the leaf, in F_2 from crosses between U. C. B. G. $\frac{68}{07}$ and $\frac{22}{07}$. *N. sanguinea,* at least so far as U. C. B. G. $\frac{25}{06}$ is concerned, is a poor and uncertain seeder. This leads one to suspect a possible hybrid origin. It has bred true in the U. C. B. G., however, for several years. This tobacco is grown, chiefly at any rate, as an ornamental plant. U. C. B. G. $\frac{25}{06}$ is well represented in plate 8. The two garden species, known as *N. sanguinea* and *N. purpurea* vary in height and robustness but those with the darker flowers are called *N. purpurea* while those with the lighter flowers are called *N. sanguinea.*

Section II. Rustica G. Don

In this second section of the genus are placed all the yellow-flowered species and varieties. The color is usually simply yellow, but, at times, in certain species, it may be mixed with red or even with white. The shape of the corolla varies much. It may be infundibuliform, hypocraterimorphous, ventricose, or

even nearly tubular. The corolla of all species of *Nicotiana* is more or less irregular, being slightly zygomorphous merely in most cases, but in two species of the *Rustica*-section, viz., *N. glutinosa* and *N. tomentosa,* it is decidedly irregular as well as being deeply tinged with red. The flowers are in simple or panicled racemes. Of about sixteen species credited by Comes (1899) to this section, six are commonly cultivated in gardens and are represented in the collections of the U. C. B. G., together with several fairly distinct varieties.

Nicotiana rustica L.

Many varieties and forms of *Nicotiana rustica* are cultivated and while, perhaps, the variability of the plants included under this name is not quite so great as is the case with those included under *N. Tabacum,* yet it is certainly very great. Forms of this species were cultivated and used for smoking by the North American Indians from Mexico and Texas north along the western banks of the Mississippi River to Minnesota, eastward to the Atlantic seaboard and north thence to Canada. It was the first tobacco cultivated by the English in Virginia, although it was soon supplanted by varieties of *Nicotiana Tabacum* brought from northern South America and the West Indies. Its culture spread to Europe, where it is cherished locally as a peasant tobacco, as well as to Asia and to Africa. It is to be expected that many varieties may be found in a species so widely and so long cultivated. Comes (1899, pp. 20-24) has distinguished six varieties, all of which have been grown in the U. C. B. G. from seed kindly furnished by Professor Comes himself. Many sowings of this species of seed from other sources have also been made and the following seven varieties have been selected for further work.

Nicotiana rustica var. **asiatica**

U. C. B. G. $\frac{12}{07}$.—*Nicotiana rustica* var. *asiatica* Schrank (1807, p. 264), as interpreted by Comes (1899, p. 22, pl. II, XII), is fairly tall, with ample leaves, which are more or less heart-shaped, and a spreading panicle. The seed came from Pro-

fessor Comes and the plant has held its characters in the U. C. B. G. since 1907. It comes near to *N. rustica* var. *jamaicensis* Comes (U. C. B. G. $\frac{15}{07}$) in its spreading habit, but the leaves are more cordate than in the latter variety. The photograph reproduced in plate 9 represents one of the less ample plants.

Nicotiana rustica var. **brasilia**

U. C. B. G. $\frac{13}{07}$.—*Nicotiana rustica* var. *brasilia* Schrank (1807, p. 264) as interpreted by Comes (1899, p. 22, pl. II, XI), is a fairly tall, robust plant, very distinct from the other varieties of *N. rustica.* The stem is stout, clothed below with large, thick heart-shaped leaves which are decidedly rugose. The panicle, when well developed, is long tapering and of massive appearance, with crowded flowers. This is well shown in the photograph reproduced in plate 10. Later, by the growth and flowering of the laterals, the panicle appears more spreading, as represented in the plate of Comes (1899, pl. XI). The seed came from Professor Comes and the plants have preserved their characteristics when bred in the pure line, in the U. C. B. G., since 1907.

Nicotiana rustica var. **humilis**

U. C. B. G. $\frac{14}{07}$.—*Nicotiana rustica* var. *humilis* Schrank (1807, p. 264), as interpreted by Comes (1899, p. 23, pl. II, XIII), is a fairly robust plant, but of low stature and early blossoming and ripening. A fairly typical plant is represented in plate 11. The leaf is broad and ovate, being broadly, but slightly cuneate at the base. The panicle is comparatively simple. This variety is nearer to *N. rustica* var. *jamaicensis* Comes than to any other variety, but is more simple in habit and with leaves more perfectly ovate with the base more cuneate and even. The seeds were obtained from Professor Comes and the plant has held its characteristics in the U. C. B. G. since 1907. This species, at least as represented by No. $\frac{14}{07}$, comes near to *N. rustica* var. *texana,* at least as represented by U. C. B. G. $\frac{17}{07}$. The two plants are still being studied.

Nicotiana rustica var. jamaicensis

U. C. B. G. $\frac{15}{07}$.—*Nicotiana rustica* var. *jamaicensis* Comes (1899, p. 21, pl. II, X) is a plant not always to be readily distinguished from *N. rustica* var. *asiatica,* on the one hand, and *N. rustica* var. *humilis* on the other. It has a less spreading habit than the former, but more than the latter. Its leaves are not so cordate as those of the former, but at the same time they are more rounded than those of the latter. It holds its characters when bred in the pure line as it has been in the U. C. B. G. since 1907. The seed was received from Professor Comes himself. It is shown in plate 12.

Nicotiana rustica var. scabra

U. C. B. G. $\frac{16}{07}$.—*Nicotiana rustica* var. *scabra* (Cav.) Comes as interpreted by Comes (1899, p. 23, pl. II, XIV) is a most characteristic plant and seems worthy of independent specific rank, so much does it differ from the other varieties of *N. rustica.* It is a tall plant and decidedly pruinose. While the plate of Comes (*loc. cit.*) represents a plant of rather spreading habit, the plants of the U. C. B. G., grown from seed sent from Portici by Professor Comes himself, are more strict; some of them are in fact of very narrow habit. Unfortunately I have no photograph to represent this number as yet, but a fairly typical specimen of this variety is represented by U. C. B. G. $\frac{26}{06}$ and is reproduced in plate 13. The var. *scabra* is not only distinct in its general habit, size, and pruinose appearance, but it has a bluish purple color to the buds and young twigs and smaller and more crowded flowers, which are greenish yellow. It lacks glands except on the flowering axes, being clothed elsewhere by a thick and compact covering of white, slender hairs abruptly bent at the middle. Above, among the flowers, these are mixed with the ordinary stalked, multicellular glands commonly found in the species of *Nicotiana.*

Nicotiana rustica var. **texana**

U. C. B. G. $\frac{17}{07}$.—*Nicotiana rustica* var. *texana* (Naud.) Comes, as interpreted by Comes, is shown in plate 14, representing a plant from pedigreed seed kindly sent by Professor Comes in 1907. It is a coarse plant, next lowest in stature to var. *humilis,* to which it approaches more nearly than it does to other varieties of *N. rustica.* Its habit is looser, as to the panicle, and the leaves are more rounded at the base. The flowers are more slender than those of *N. humilis.* On the whole, however, the two varieties are very close to one another. (cf. plate 14).

Considering all the varieties and forms of *Nicotiana rustica* which I have been able to obtain and cause to grow in the U. C. B. G., the varieties *brasilia* and *scabra* are the most distinct, yet all have more or less definite points of distinction. Most of the plants of this species from other sources which have been grown may be referred more or less definitely to one or other of the six varieties enumerated above or seem to be intermediate between some two of them. One other stock, besides those mentioned above has been retained, viz., *U. C. B. G.* $\frac{169}{08}$.

Nicotiana rustica var. **pumila ?**

U. C. B. G. $\frac{169}{08}$.—This is referred with doubt to *Nicotiana rustica* var. *pumila* Schrank (1807, p. 264) and is represented in the photographs reproduced in plates 15 and 16. This plant is the lowest of all the members of the *N. rustica* assemblage which have come under my observation. It is 12 to 14 inches high, matures early, and is loose in habit. Its leaves are ovate-lanceolate and unequal at the base. They are small compared with those of the other varieties of *N. rustica.* For three seasons, bred in the pure line, it has retained its lowly habit, earliest flowering of all the varieties of *N. rustica,* and its narrow leaves.

Nicotiana Langsdorffii Weinm.

This species was described by Weinmann (p. 323) and by Schrank (pl. 72) in 1819 as coming from Brazil and was intro-

duced into cultivation the same year apparently. It was originally collected by Langsdorff, who sent the seeds to Weinmann. The description speaks of the flowers as green and the anthers as azure. The type of the species is a fairly well-known garden plant. It has been cultivated in the U. C. B. G. under various numbers, such as $\frac{22}{02}$ and $\frac{102}{05}$. The latter number is well represented in the photograph reproduced as plate 17.

N. Langsdorffii is a plant of three or four feet in height, of loose and spreading habit. Its leaves are elliptical-lanceolate, patent, narrowed and sessile by a long decurrent base. They are decidedly rugose above. The corollas are funnel-shaped below with a gibbous ring above and a concave, spreading limb slightly notched in five broad, shallow lobes. They are greenish yellow and pendent, or at least nodding. The pollen is azure. The capsules are for the most part 2-celled, but 3-celled capsules are not uncommon.

While the type is unmistakable and is well represented in the plates in the *Botanical Magazine* (cf. Sims, 1821, pl. 2221 and 1825, pl. 2555), there are plants often referred to it which Comes has mentioned as varieties.

N. Langsdorffii var. *grandiflora* Comes (1899, p. 28) is the plant of the gardens usually known as *N. commutata* Fischer et Meyer (1846, III, p. 377). It is a plant of less slender and less spreading habit, larger flowers, which are more deeply notched, more decidedly zygomorphous, and with the limb more spreading. The outside of the corolla is greenish yellow as in the type, but the inner (upper) surface of the corolla is milk-white. The flowers also are ascending, not pendent or hanging. The pollen is slightly bluish, not at all azure, but the anther coats are purplish brown. Altogether, the characters recall those of *Nicotiana alata* var. *grandiflora* Comes (1899, p. 37) which is *N. affinis* Moore (1881, p. 141, fig. 31), except that the flowers are smaller and more decidedly yellow outside. It may be of hybrid origin. It is said to have been known in gardens since 1835, but its native country is uncertain. In the U. C. B. G., it is represented by number $\frac{107}{08}$ (cf. plate 18), where its behavior is being studied and about which it is hoped to publish

something at a later date. Thus far it has produced both whites and pure yellows. Lock (1909) has made some experiments in crossing *N. Langsdorffii* and *N. alata,* with very interesting results as to corolla-shape and color, and also as to color of the pollen. Both the F_1 and the F_2 generations in Lock's experiments presented intermediates.

N. Langsdorffii var. *longiflora* Comes is another intermediate sort of variety described by Comes (*loc. cit.*). I have not had any plants which answer exactly to his description, but under No. $\frac{173}{08}$ U. C. B. G. (cf. plate 19), there appeared yellow-flowered forms (even the inner, or upper, surface of the limb being yellow) which comes close to it, as do also certain plants cultivated under the number $\frac{70}{06}$ U. C. B. G., which also have given both yellow and white-limbed flowers. All these are being bred in pure line to be reported on later.

Nicotiana paniculata L.

This well-known and widely cultivated species has been grown in the U. C. B. G. under several different numbers and from several different sources. No. $\frac{106}{05}$ U. C. B. G. is well represented in the photograph reproduced in plate 20. It is a spreading plant up to three or four feet high, the panicle being very effuse. The leaves are broad and slightly cordate, moderately long petioled. The flowers are pale yellow and long tubular, being slightly gibbous just below the limb. The limb is narrow, at first concave, but flattened or somewhat reflexed in full anthesis, broadly and very slightly rounded five-lobed. The capsule is narrow.

This species is reported to have been under cultivation since the middle of the eighteenth century, having been discovered in Peru in 1752. The plant in the Linnaean Herbarium is exactly the one grown in the U. C. B. G. It is said to be used as a tobacco for the pipe, being mild and of exquisite aroma. It remains constant when cultivated, although at times the flowers are curved nearly into a circle.

Nicotiana glauca Graham

N. glauca is a tree tobacco, since it is a perennial and forms a trunk of considerable height and girth. It has spread from its original habitat into a considerable number of tropical and warmer temperate countries. It is probably a native of central South America. It is a common escape in Southern California where it is thoroughly naturalized and commonly reaches a height of ten or twelve feet. It grows fairly well in central California too and has appeared in abundance in San Francisco in the section burned over in 1906. The stem is woody and much branched. The leaves are long petioled, ovate-lanceolate, glabrous and glaucous. It is the most nearly glabrous *Nicotiana* we have cultivated in the U. C. B. G. (No. $\frac{5}{10}$). The flowers are pale yellow, long tubular, slightly gibbous above and with the almost pentagonal limb deeply concave. In flower, it comes nearest to *N. paniculata.* W. J. Hooker has accurately figured and described it (1827, pl. 2837). Comes (1899, p. 27) has described three varieties which I have not, as yet, been able to distinguish.

Nicotiana glutinosa L.

This is one of the most peculiar of the annuals of the section *Rustica* in its foliage and its flowers. It is a very robust plant, as represented in the photograph reproduced in plate 21. The leaves are broadly and deeply cordate and abruptly acuminate. The whole plant is pubescent-villose and extremely glandular sticky. The racemes are long, circinate at the tip, and with the flowers alternate in two ranks on the same side. The flowers are unlike those of any *Nicotiana* in shape except those of *N. tomentosa.* They are short cylindrical below, suddenly swollen above, where they open out in an irregular obliquely one-sided funnel. The limb is fairly bilabiate, the stigma and anthers being connivent just under the middle lobe of the upper lip. The color is light yellow tinged with deep red. The flowers easily fall especially when there is a drop in temperature. Under No. $\frac{79}{07}$ it has been cultivated in the U. C. B. G., in the

pure line, for several years and retains its characters perfectly. The plant in the Linnaean Herbarium is exactly the one cultivated in the U. C. B. G. and elsewhere, and which passes universally under this name.

Nicotiana tomentosa Ruiz & Pavon.

N. tomentosa is a second "tree tobacco" rivalling *N. glauca* in height and exceeding it in display as a foliage plant because of its huge leaves. U. C. B. G. $\frac{193}{08}$ is the number applied to plants of this species grown in Berkeley, where one plant has survived three winters outside, the first under protection of a cheese-cloth tent and with some heat at nights, the second and third without protection. It is now a bushy plant of spreading habit, about twelve feet high, and has blossomed thrice, but since it begins to blossom in midwinter, few of the earlier blossoms arrive at anthesis. Some of the latest do, however, and in the present year (1912), it has produced abundant panicles for several months. The shape of the corolla is nearest to those of *N. glutinosa,* being obliquely inclined, very gibbously inflated into a broad funnel above and nearly bilabiate. The color is light yellow tinged with red. The style and stamens are exserted, projecting fully as much as the length of the corolla. Both flowers and leaves are well figured by Hooker (1892, pl. 7252). On account of the peculiarities of the flower, Sprengel (1817, p. 458) made it the type of his new genus, *Lehmannia.* It was named by André (1888, p. 511) *Nicotiana colossea,* and it has appeared in gardens and has been cultivated as a foliage plant under this name. It is usually raised under glass and placed outside only in the warmer season. It begins to flower in the U. C. B. G. in December and continues to do so for several months. It is a native of Brazil and Peru. A small plant grown from a cutting is represented in plate 22.

Section III. Petunioides G. Don.

The species of Nicotiana belonging to the *Petunioides*-section have salver-shaped corollas, which are white or tinged with red or purple, arranged in racemes or panicles. In this section,

I have included the section *Polidiclia* of G. Don, an arrangement which seems to me natural and which I shall hope to justify further on (cf. also Miers, 1846, p. 182 and East, 1912). Of the twenty-four species included by Comes (1899) in these two sections, ten are cultivated in the U. C. B. G.

Nicotiana noctiflora Hook?

The description of this species as given by W. J. Hooker (1827, pl. 2785) is such that I hesitate to apply the name to the plants cultivated for several years in the U. C. B. G. under No. $\frac{9}{07}$. The principal differences are in the corolla lobes and in the inflorescence. The corolla lobes are represented as broad and emarginate by Hooker. In our plant they are broad and bluntly pointed, but the blunt point is revolute and the superficial appearance is of a blunt and emarginate lobe. The inflorescence represented in Hooker's plate is more paniculate than I find in the U. C. B. G. plants. The leaves appear to be very much the same in both.

U. C. B. G. $\frac{9}{07}$ came from seed sent by Professor O. Comes and was labelled "*Nicotiana noctiflora* var. *albiflora.*" Its habit is low (about two feet in height), rather effuse, and sprangly. The leaves are coarse, especially the lower ones. They are elliptical-lanceolate to simply broadly lanceolate, sessile and slightly clasping at the base, more or less bullate above, slightly toothed, sinuous and undulate, with sparse, coarse prickly hairs. The upper leaves are narrowly linear-lanceolate, very much and coarsely crisped. The flowers are in long simple racemes. The corolla is salver-shaped, with a slender tube, about double the length of the calyx, and expanded gently at the summit. The five lobes of the limb are broad and deep, abruptly contracted at the tip, which is revolute, thus giving the lobes a certain appearance of being broad and obcordate. The corolla is reddish purple without and white, or slightly purplish, within. U. C. B. G. $\frac{9}{07}$ is a near relative of N. *longiflora,* from which it is to be distinguished particularly by its strictly annual character, lower habit, its lack of a long persistent basal rosette of radical leaves, and much shorter corolla. Although it seems to pass for *N.*

noctiflora, it may well be doubted whether it is identical with the plant described under this name by W. J. Hooker (*loc. cit.*). So far as flower and inflorescence is concerned, Hooker's plant seems to be nearer to *N. acuminata*. Hooker's plant is credited as being perennial, ours is annual. The flowers open at about 7:30 P.M. and close by 8 A.M They are odorless. U. C. B. G. $\frac{9}{07}$ is shown in plate 23.

Nicotiana longiflora Cav.

The present species is fairly well known in botanical gardens and as a weed in warmer countries. It has appeared in the eastern United States as a ballast weed. It has been grown in the U. C. B. G. under several numbers, from as many different sources. No. $\frac{100}{05}$ has been the principal cultivation and the plant (in daytime with its flowers closed) is well represented in the photograph reproduced in plate 24. One characteristic of *N. longiflora* is very striking in contrast with other species of *Nicotiana* cultivated in the U. C. B. G. and that is, the forming of a compact rosette of large, coarse leaves which lie flat on the ground and persist for a considerable time before the flowering stems arise from it. The rosette persists for most of the first year and is well represented in the figure just quoted. The flowering stems are spreading, bearing narrower leaves than the radical ones, and the loose panicle bears somewhat distant flowers with long, slender, bluish-purple corollas.

The radical leaves are broadly lanceolate or oblanceolate, coarsely bullate and rugose above, undulate, smooth but with coarse spine-like glandular hairs on surface and margins. The tube of the corolla is four to six times as long as the calyx and proportionally slender. The broad spreading limb is deeply divided into five moderately broad blunt-pointed lobes, which are somewhat recurved. The flowers open only at night. Occasionally a 3-celled capsule is found. In the U. C. B. G., No. $\frac{100}{05}$ has persisted as long as three years, but no more. It usually lives for two years, at least.

U. C. B. G. $\frac{104}{08}$ seems to be the *N. longiflora* var. *acutiflora*

of Comes (1899, p. 44). It was received under the name of *Nicotiana acutiflora,* as have been also one or two other plants from other sources. Our plant is certainly very near to *N. longiflora,* as cultivated in the U. C. B. G., differing chiefly in the decidedly more yellowish green stems and foliage, flowers greenish white with only a slight tinge of purple in some of them, more sinuous lobes recurved to the limb of the corolla, and more conduplicate and twisted cauline leaves. Its perennial character in the U. C. B. G. is limited to two or three years, as in typical *N. longiflora.*

Nicotiana alata Link et Utto.

Nicotiana alata in one form or another has been a favorite in cultivation for a long period, partly for ornamental purposes, but partly, it is claimed by many authorities, to provide the Persian tobacco so highly esteemed for its delicacy and perfume. The most commonly cultivated variety is the plant called *Nicotiana affinis* Moore (1881, p. 141, fig. 31). Comes (1899, p. 37) has designated this as var. *grandiflora* of *N. alata.* Another variety of *N. alata,* according to Comes, is *N. persica* Lindley (1833, pl. 1592). This is *N. alata* var. *persica* (Lindl.) Comes (1899, p. 36). The differences between these three (?) sets of plants seem to be largely in the more or less amplexicaul base of the leaf as well as its varying degree of decurrence, the varying size of the flower, and the variety exhibited in the disproportionality (zygomorphism) between the upper three lobes of the limb of the corolla and the lower two. In the type of the species, all five lobes are said to be very nearly equal, obtuse and not emarginate and the limb very little oblique; in var. *persica* the limb is said to be decidedly oblique, the lobes scarcely unequal but strongly emarginate; in var. *grandiflora* the tube of the corolla is said to be longer and stouter, the limb very oblique, broader, with larger lobes, the lower two being much the larger, but only slightly emarginate.

I have cultivated several different sets of *N. alata* in the U. C. B. G. and have obtained a variety of plants, but without being able to separate the varieties satisfactorily. The plants, clearly and distinctly belonging to *N. alata,* are all of var.

grandiflora or very close to it. What seems in many ways to be the var. *persica* is represented by U. C. B. G. $\frac{107}{08}$. It was received under the name of *N. viscosa*. I have referred to it in the present account under *N. Langsdorffii* var. *grandiflora*. The corolla tube is provided with a gibbous ring at the summit. It is to be suspected as of hybrid origin, the most probable parents being *N. alata* var. *grandiflora* and *N. Langsdorffi*. It has given plants both yellow and milk-white for the color of the upper surface of the limb of the corolla during cultivation in the U. C. B. G.

N. alata var. *grandiflora* is represented by U. C. B. G. $\frac{98}{05}$ (cf. photograph, reproduced in plate 25), and by U. C. B. G. $\frac{1}{06}$. They are both clearly the *N. affinis* of the gardens, but differ slightly from one another. The flowers are large, with the tube gradually enlarging up to the limb and with very little trace of a gibbous swelling at the very top and that only on the upper side. The tube is greenish yellow without and the lower (outer) surface slightly purplish. *N. alata* var. *grandiflora* has been crossed with *N. Forgetiana* Hemsley (1905, pl. 8006) to produce the brilliant red plant of the gardens known as *N. Sanderae*. This hybrid has been grown in the U. C. B. G. under several numbers and has exhibited a considerable variety of form and color of flower and some variability in habit and fertility. All the true *N. Sanderae* show the influence of the red-flowered parent (*N. Forgetiana*) not only in color, but also in the strongly developed gibbous ring in the throat of the corolla just below the limb. Other hybrids of *N. alata* var. *grandiflora* are known in gardens, with flowers varying from white, through pink and red to dark purple (bluish in fading). In size and shape, the flowers, as well as the habit, vary very little from typical *N. alata* var. *grandiflora*. U. C. B. G. $\frac{174}{08}$ is such a hybrid, giving uniformly dark-red flowered plants in pure-line breeding.

Nicotiana acuminata (Graham) Hook.

Our knowledge of *Nicotiana acuminata* is based on W. J. Hooker's (1829, pl. 2919) description and plate. In the U. C.

B. G., there have been cultivated several plants which seem certainly to belong to the same species. They differ from one another slightly, but chiefly in the varying diameter of the limb of the corolla. Comes (1899, p. 39) has described two varieties based on this character and we have followed him in adopting designations for our plants. The *acuminata*-group is to be distinguished from the *longiflora*-group by having the lobes of the limb of the salver-shaped corolla comparatively shallow and rounded. The varieties of *N. acuminata* have petioled leaves, whose blades are almost or quite cordate below but ovate-lanceolate to narrowly lanceolate above. The plants are rather spreading at maturity, as represented in plate 26. The seed of the type of the species (apparently var. *parviflora* Comes) came originally from Chili (Hooker, *loc. cit.*). One of the varieties (var. *grandiflora* Comes, cf. plate 26) probably originated (or segregated) under cultivation, but one or more varieties occur wild in California. Since the subject of *N. acuminata* and its varieties is to be treated by T. H. Goodspeed in a paper about to appear in this series, nothing further will be said about its characters here. Plants belonging to this species appear in botanical gardens under the names of *N. suaveolens* and of *N. vincaeflora,* Australian plants which were at one time cultivated but of which I have been unable to get reliable seed. I suspect that most of the plants cultivated under these names belong to *N. acuminata,* from which they are to be distinguished by their lack of a petiole.

Nicotiana attenuata Torr.

This is a widespread species of Western North America, extending from New Mexico, Arizona, and southern California, east as far as Colorado, and north through Wyoming to southern British Columbia. It grows in arid and desert localities, as a slender, often decidedly bushy herb of straggling habit. It is well represented by Watson (1871, pl. 26, fig. 1, 2) in his figure in the *Botany of King's Expedition,* except that the flowers seem to be sharp-lobed and funnel-shaped, while the large very extremely swollen-based glandular hairs are not

represented. The large swollen based hairs are most characteristic and constitute a mark of identification. They are usually very conspicuous upon the calyx. The plant bears a certain fairly close but superficial resemblance to the last (*N. acuminata*), especially to the smallest flowered varieties. It differs from it in the swollen-based glands just mentioned, in the lower leaves never being so broadly ovate or even cordate at the base, and in the shorter, stouter tube of the corolla. The leaves are petioled and lanceolate or ovate-lanceolate and the lobes of the limb of the corolla are broad and shallow, but not emarginate. It has never been cultivated to any extent and does not grow well in the adobe soil of the U. C. B. G. Two numbers, viz., U. C. B. G. $\frac{78}{09}$ and $\frac{46}{11}$, have been grown with fair success. Both numbers are from plants used by Indians for smoking, the former from seed from Oregon, the latter from seed from British Columbia. It seems to have been smoked by the Indians throughout its range to some extent, at least wherever it was the chief or only species of *Nicotiana* to be obtained. In the northern part of its present range it was undoubtedly introduced by the Indians.

Nicotiana Bigelovii (Torr.) Watson.

One of the most interesting of all the *Nicotiana* species cultivated in the U. C. B. G. is this species of California and, to some extent perhaps, of adjacent states. It has been cultivated in various forms and under various numbers in the U. C. B. G. since 1905, these latter years in pure lines. I do not think that it has been successfully cultivated elsewhere to any extent (cf. however Comes, 1899, p. 43 and East, 1912) and the only time I saw the name was in the seed-list of a botanical garden. I obtained some of the seed but the plants proved to be *N. longiflora*. It does not grow readily or uniformly in the U. C. B. G., but it has always given some results and these have been of such interest that I expect to give them more in detail later.

What passes for the type of *Nicotiana Bigelovii* is a large and tall, coarse plant with large white or purplish (outside) corollas which are five-lobed. The leaves are sessile and usually

tapering towards the base, although, in some plants, some of the leaves are truncate at the base and partly clasping. The capsule is large and two- or three-celled. It generally grows in sandy banks or bottoms of rivers, overflowed in spring, but dry in summer. There are several variations of the type upon which it is hoped to report later. U. C. B. G. $\frac{40}{05}$ represents such a plant, while U. C. B. G. $\frac{60}{07}$ a, represents a lower, spreading plant which may possibly be nearer the strict taxonomic type. The figures given by Watson (1871, pl. 26, fig. 3, 4) in the Report of the Botany of King's Expedition resemble U. C. B. G. $\frac{60}{07}$ a, more nearly than any other and the type (or cotype) in the Gray Herbarium of Harvard University seems to be the same. These plants are the more common in central California. *N. Bigelovii* var. *Wallacei* Gray is a slender plant, with slender, narrower corolla, with elongated deltoid leaves. This is the more abundant form in Southern California. U. C. B. G. $\frac{43}{05}$ represents this type.

Nicotiana quadrivalvis Pursh.

Nicotiana quadrivalvis seems to be a lost species in nature. It was described by Pursh (1814, pp. 141, 142) from the plants collected by Lewis and Clark in their expedition across the continent. Lewis and Clark got their plants from the Ricaree Indians who cultivated it. The type-specimen is still preserved in the Herbarium of the Academy of Natural Sciences at Philadelphia, where I have had the opportunity of examining it through the courtesy of Mr. Stewardson Brown. It seems exactly like the plants developed in the U. C. B. G. and somewhat unlike the plants grown in the past in various botanical gardens. It was introduced into gardens in 1811 (cf. Don, 1838, p. 466) and was figured by Sims (1816, p. 1778). Lehmann (1818, p. 45, pl. 4) also described and figured it. How long it persisted in botanical gardens is not certain, but it seems to have been extensively cultivated, judging from herbarium specimens. It is still offered in some seed-lists, but seed obtained from such lists have given me only varieties of *N. Tabacum* or *N. rustica.*

Comes (1899, p. 54) indicates that he has seen it in the living condition. Seed received from him failed to germinate in the U. C. B. G., even after repeated trials. East (1912, p. 244) has just stated that he succeeded in producing plants from Italian seed and that these were so close as to seem of the same species with a derivative of *N. Bigelovii* produced in the U. C. B. G., of which East was furnished with seed.

As to the wild plant, I have considerable doubt as to its ever having existed. In various floras it is listed without special comment, but very few specimens other than those from botanical gardens are to be found in the herbaria and even such other specimens are likely to have been from Indian cultivation. Some of such specimens, however, are either robust *N. Bigelovii* or *N. multivalvis*. Gray (1876, p. 546) suggests that it is merely a cultivated variety of *N. Bigelovii* to which it is very close in every character except that of the four-celled capsule and its tendency to have more than five lobes to the corolla. My experience with *N. Bigelovii,* especially U. C. B. G. $\frac{35}{05}$, seems thoroughly to support this statement, since *N. quadrivalvis* has appeared in a pedigree of *N. Bigelovii* (cf. also East, 1912, p. 245 et seq.).

Nicotiana multivalvis Lindl.

This plant is more commonly assigned as a variety under *N. quadrivalvis,* which it resembles closely except in the many-celled indehiscent capsule, in which the cells are arranged in both an inner group and an outer row and the many-lobed limb of the corolla. In fact, *N. multivalvis* (cf. Lindley, 1827, pl. 1057) seems like a monstrous form of *N. Bigelovii.* Yet it is reproduced uniformly from the seed. U. C. B. G. $\frac{90}{06}$ and $\frac{143}{07}$ have been grown for several years in the U. C. B. G., mostly in the pure line, giving constant results. Gray (1876, p. 546) suggests that "*N. Bigelovii* is perhaps the original of it," and I feel that he is right, since it has appeared in the pedigreed cultivation of *N. Bigelovii* in the U. C. B. G.

N. multivalvis has been cultivated in botanical gardens since 1826 (cf. Don, 1838, p. 467) and still persists. The first seed were procured by David Douglas (1836, p. 92), who obtained

it in 1825 on the banks of a small branch of the "Multnomak River," one of the southern tributaries of the Columbia River. The plants cultivated today are, with little doubt, descended from the plants grown from the seed collected by Douglas. No plants of *N. multivalvis* are found wild at the present time, and it is more than probable that even in the time of Douglas it was not known except in Indian cultivation. It is still cultivated and used ceremonially by certain Indian tribes.

Nicotiana repanda Willd.

Lehmann (1818, p. 40, pl. III) is responsible for the publication of this species which Willdenow apparently christened as an herbarium specimen. The native country of the type specimen is given as Cuba. The species grows in Mexico and southwestern Texas, where seeds were obtained through the kindness of Professor F. D. Heald of the University of Texas. The plants are not easily grown but have been continued on under U. C. B. G. $\frac{79}{09}$. They agree with Lehmann's figure (*loc. cit.*) as well as with that of Sims (1823, pl. 2484). They are well represented by the photograph reproduced in plate 27. Our plant is probably the *N. repanda* var. *pandurata* (Dunal.) Comes (1899, p. 47).

Nicotiana trigonophylla Dunal.

In the southwestern United States and northern Mexico, in the drier regions, there grows a species which varies quite a little, which has been, and even still is, used by certain Indian tribes for smoking. This is *Nicotiana trigonophylla.* It has been grown, but with difficulty, in the U. C. B. G. for several seasons under Nos. $\frac{95}{07}$ and $\frac{6}{09}$. The seed of the former was from San Bernardino County and of the latter from Inyo County, both of the State of California. In both cases it was from wild plants.

In 1911 by planting in soil well underdrained and by using cheese-cloth protection, the plants were grown successfully and some of them with protection have even withstood the winter.

The species is correctly placed in the *Petunioides*-section of

Nicotiana, although the flowers are a yellowish white. The individuals vary in being more green or more glaucescent. They are straggly, with narrow, broadly lanceolate leaves narrowed at the base and then suddenly expanded into broad, partly clasping auricles. The flowers are in more or less incurved, one-sided racemes. The corolla tube is almost straight tubular, with the limb spreading at right angles or slightly deflexed in full anthesis. The lobes of the limb of the corolla are broad, obtuse, and shallow. The flowers are deep creamy yellowish white. The capsule is nearly or entirely enclosed in the calyx, varying in this respect. Var. *pulla* Comes (1899, p. 49), var. *sordida* Comes (*loc. cit.*) and var. *ipomopsiflora* Comes of *N. trigonophylla* and *N. Palmeri* Gray (1886, p. 242) seem to belong to the same species.

Nicotiana sylvestris Speg. & Comes.

This is one of the most important of the showy species of *Nicotiana* for garden culture. Spegazzini sent the seeds from Argentina to Comes in 1897 (cf. Comes, 1899, p. 35), and the plant was soon widely distributed in botanical and other gardens. It has been grown continuously in the U. C. B. G. since 1901. It is a tall, shortlived perennial with long, slender white flowers, pleasantly fragrant after dark. A slender plant just coming into flower is represented in the photograph reproduced in plate 28. The figure of Comes (*loc. cit.,* p. 34) does not well represent the proportions of height, length of leaf, and length of flower as found in the plants cultivated in the U. C. B. G. The plate of J. D. Hooker (1899, pl. 7652) is better in these respects, but the habit-figure does not seem characteristic. The plant represented from the U. C. B. G. is young; older plants branch and become more bushy. The flowers are long and white, with a slight tinge of yellowish outside. The tube is slender, enlarging slightly and gradually above the middle but gradually contracting below the top. The limb is moderately broadly lobed one-third to one-half way in from the margin. The lobes are broadly triangular. The flowers are pendent in bud,

ascending to nearly horizontal as anthesis proceeds. While they are open in the daytime as well as at night their perfume is faint until after nightfall. The ripened capsules are erect. The leaves are elliptical to spatulate-oblong with a broad clasping and slightly decurrent base. They are coarsely rugose.

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EXPLANATION OF PLATES

All the plates are from photographs taken by Mr. B. F. White under the direction of W. A. Setchell.

PLATE 1

"Brazilian" Tobacco. U. C. B. G. $\frac{71}{05}$. $\times 3/32$ diam.

71
05

PLATE 2

''Cavala'' Tobacco. U. C. B. G. $\frac{72}{05}$. $\times \frac{3}{32}$ diam.

72
05

PLATE 3

"Maryland" Tobacco. U. C. B. G. $\frac{78}{05}$. $\times 7/64$ diam.

1850

PLATE 4

Nicotiana Tabacum var. calycina. U. C. B. G. $\frac{110}{05}$. $\times 9/64$ diam.

110
05

PLATE 5

"White Tobacco." U. C. B. G. $\frac{30}{06}$. $\times 11/128$ diam.

30
06

PLATE 6

Nicotiana Tabacum var. macrophylla. U. C. B. G. $\frac{22}{07}$. $\times \frac{15}{64}$ diam.

I
22
07

PLATE 7

Nicotiana angustifolia. U. C. B. G. $\frac{68}{07}$. $\times 21/128$ diam.

O
68
07

PLATE 8

Nicotiana Tabacum var. macrophylla purpurea. U. C. B. G. $\frac{25}{06}$. $\times 5/64$ diam.

25
06

PLATE 9

Nicotiana rustica var. asiatica. U. C. B. G. $\frac{12}{07}$. $\times 2\frac{1}{128}$ diam.

O
12
07

PLATE 10

Nicotiana rustica var. brasilia. U. C. B. G. $\frac{13}{07}$. $\times \frac{1}{8}$ diam.

X
13
07

PLATE 11

Nicotiana rustica var. humilis. U. C. B. G. $\frac{14}{07}$. $\times 15/64$ diam.

X
14
07

PLATE 12

Nicotiana rustica var. jamaicensis. U. C. B. G. $\frac{15}{07}$. $\times 11/64$ diam.

PLATE 13

Nicotiana rustica var. scabra. U. C. B. G. $\frac{26}{06}$. $\times 7/64$ diam.

26
Nb

PLATE 14

Nicotiana rustica var. texana. U. C. B. G. $\frac{17}{07}$. $\times 3/16$ diam.

O
17
07

PLATE 15

Nicotiana rustica var. pumila? U. C. B. G. $\frac{169}{08}$. $\times 7/16$ diam.

169
08

PLATE 16

Nicotiana rustica var. pumila ? U. C. B. G. $\frac{169}{08}$. $\times 31/128$ diam.

80
101

PLATE 17

Nicotiana Langsdorffi. U. C. B. G. $\frac{102}{05}$. $\times \frac{1}{8}$ diam.

102
05

PLATE 18

Nicotiana Langsdorffii var. grandiflora? U. C. B. G. $\frac{107}{08}$. $\times 1\frac{3}{64}$ diam.

107
08

PLATE 19

Nicotiana Langsdorffii var. longiflora ? U. C. B. G. $\frac{173}{08}$. × 11/64 diam.

173
08

PLATE 20

Nicotiana paniculata. U. C. B. G. $\frac{106}{05}$. $\times 11/64$ diam.

106
05

PLATE 21

Nicotiana glutinosa. U. C. B. G. $\frac{79}{07}$. $\times \frac{1}{8}$ diam.

(The label $\frac{79}{09}$ should be $\frac{79}{07}$).

79
07

PLATE 22

Nicotiana tomentosa. U. C. B. G. $\frac{193}{08}$. $\times 13/64$ diam.

(A small plant grown from a cutting).

PLATE 23

Nicotiana noctiflora? U. C. B. G. $\frac{9}{07}$. $\times 13/64$ diam.

9/07

PLATE 24

Nicotiana longiflora. U. C. B. G. $\frac{100}{05}$. $\times \frac{1}{8}$ diam.

(The flowers are closed; daytime condition).

100
05

PLATE 25

Nicotiana alata var. grandiflora. U. C. B. G. $\frac{98}{05}$. $\times \frac{3}{32}$ diam.

(The flowers are closed; daytime condition).

PLATE 26

Nicotiana acuminata var. grandiflora. U. C. B. G. $\frac{150}{07}$. $\times \frac{9}{64}$ diam

150
07

PLATE 27

Nicotiana repanda. U. C. B. G. $\frac{79}{09}$. $\times 9/64$ diam.

PLATE 28

Nicotiana sylvestris. U. C. B. G. $\frac{107}{01}$. $\times \frac{3}{32}$ diam.

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